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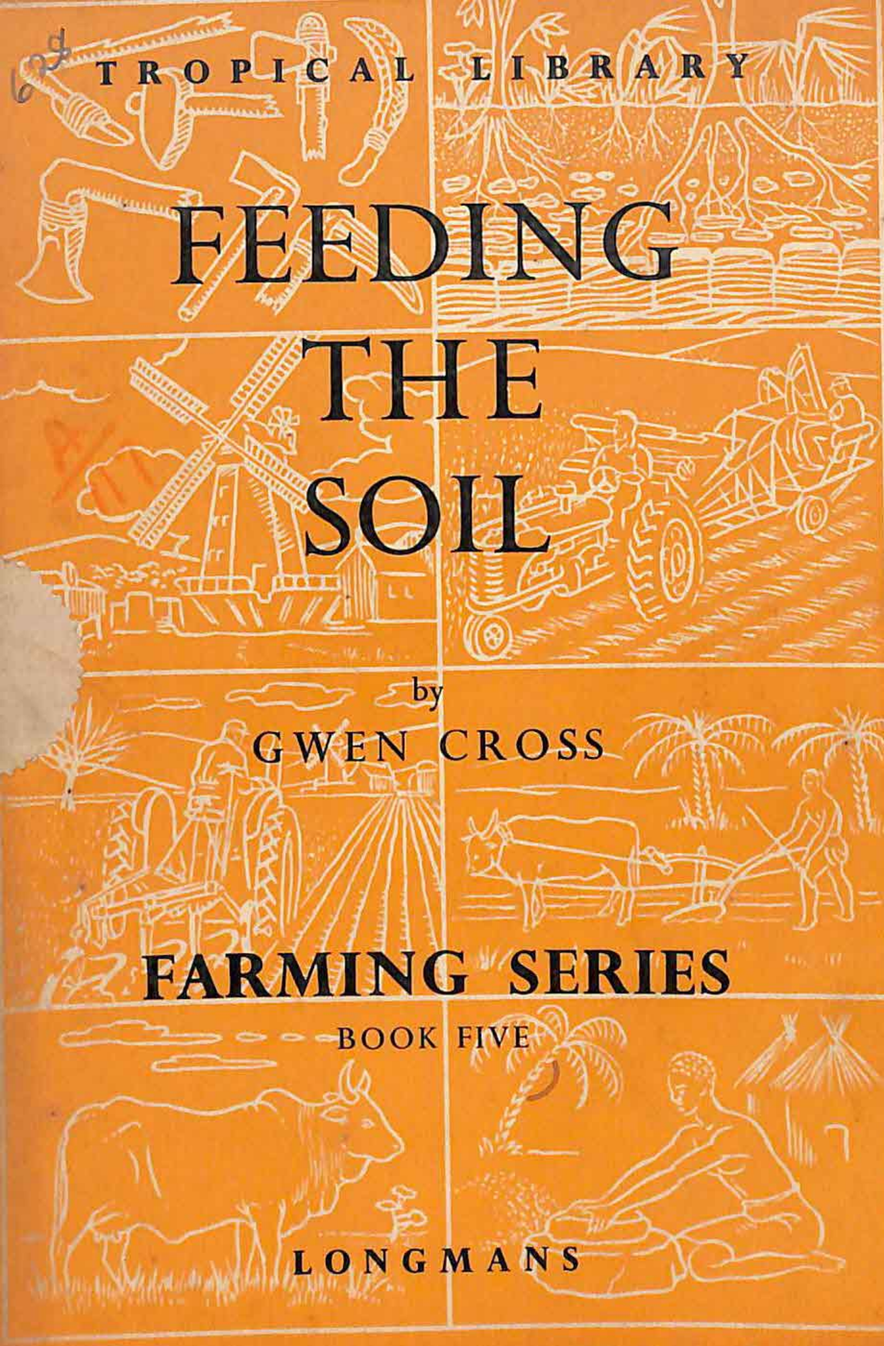

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FOREWORD

If you have read the earlier books of this series, you have learned how the soil was made, how it got its humus, how men changed the soil and often did damage to it by not replacing the plant food their crops had used. In this book you will read how you can help your soil by growing and burying green manures and cover crops.

CHAPTER 1

BURYING WEEDS AND GRASS

EVERY part of a dead plant rots in the soil, but the soft, green parts rot more quickly than the hard, woody parts. Plants are most useful as manures if they are buried when they are young and still soft and green, but we cannot bury our food crops at this stage. If we did, we would get no harvests from them. We can, however, plant and bury other crops which will help the soil. We can also bury some weeds and green grasses before their seeds come. Other weeds and grasses we should always burn, because, if they are buried, there is a danger that they will grow again.

Farmers say, "Weeds are thieves", and "One year's seeds are seven years' weeds." If we pull up weeds, burn the bad ones and bury the others before their seeds are ready, we shall soon have less weeding to do, and we shall also help our soil.

There are two ways in which farmers bury weeds and grasses. Sometimes they dig shallow trenches in lines across the garden. Sometimes they dig holes where the weeds are growing. Most weeds will die if they are put flat in a trench and covered with soil. We have to be more careful with grasses, for some will grow again unless we burn them, while others will often grow again if laid flat. Any grass we bury must be put in the soil with the leaves pointing downwards and the roots pointing upwards.

Some farmers can bury the safe kinds of grass very quickly so that they will not grow again. They hold the hoe in the right hand, and use the left hand for the grass. They dig out the grass with its roots, then dig more soil out to make the hole deeper. They push the grass into the hole with its roots up, then quickly replace the soil with the hoe.

One of the most important ways in which we can help our soil and our crops is by burying weeds and grass in the gardens. We should never burn them, unless they are of the kinds which will grow again if buried, or throw them away at the side of the garden. We should use them to feed the soil, which feeds our crops, which in turn feed us.

QUESTIONS

1. Write down the new words in this lesson and learn them.
2. What harm do weeds do in a garden?
3. How can weeds be made to help the soil?
4. Why must we bury or burn weeds and grasses before the seeds come?
5. Why must we bury grass with its roots pointing upwards?

CHAPTER 2

GREEN MANURES

GREEN manures are plants which are buried when green in order to feed the soil. Young weeds and grasses help the soil when buried in it, but the best green manures are plants of the legume family such as the cow pea, the pigeon pea, other peas and beans, *Crotalaria*, *Sesbania*, clover, lucerne, *Calopogonium*, *Tephrosia*, and many others. Some of these are climbing or creeping plants, while others grow tall and straight. Crops grown as green manure are closely planted, so as to get as much food as possible to put into the soil.

Climbing and creeping legumes give most food to the soil if they are buried when the first fruits to form are little green pods about three-quarters of an inch to an inch long. At this time the stems are still soft and green, and the microbes in the root nodules have the greatest amount of nitrogen ready to feed the fruits and the seeds. This food is all easily changed to plant food in the soil. If the plants are buried earlier than this, they do not contain so much plant food. If they are buried later, some of the food will have been used by the growing plants to build up their own fruits and seeds. When plants are forming their fruits and seeds they take more food from the soil than at any other time.

Tall, straight growing legumes can be buried as green manure when they are two and a half or three feet high. If they are left longer the stems grow hard and woody. Most of the tall legumes do not begin to flower until they are taller than three feet. If they begin to flower before they are this height, they should be buried at once.

When tall legumes are grown for green manures, the seeds are planted close together, with narrow spaces between the lines, so as to make "belts" of the crop. There should be a space of one to one and a half feet between the belts. Sometimes the seeds are scattered over the whole garden.

Tall legumes are also grown as cover crops (see Ch. 8).

QUESTIONS

1. Write down the new words in this lesson and learn them.
2. What are green manures?
3. Name three plants that can be used as green manures.

4. When would you bury a creeping legume as green manure? Why would you bury it at this time?

5. When would you bury a tall legume as green manure? Why do you not wait for the flowers to appear?

CHAPTER 3

MORE ABOUT GREEN MANURES

IF we are to make the best use of green manures there are a number of things we must remember:

1. In sandy soils green manures rot quickly. They can be buried deep, while they are fresh and green.

2. Green manures rot slowly in clay soils. They should not be buried deep, or when they are fresh and green. Before they are buried they should be allowed to dry for two or three days on top of the soil.

3. Green manures should not be buried when the soil or the plants themselves are very wet. If this is done, the nitrogen in the soft, wet, green plants may be set free into the air instead of being changed by the microbes into nitrates for the soil. This means that plant food is lost.

4. Creeping green manures should be buried before their stems become woody and before the first fruits to appear begin to get big; tall green manures should be buried before the flowers appear.

5. When we wish to bury green manure, we should not pull up the roots with the plants and leave them on top of the soil in the hot sun. Hot sunshine kills the microbes in the root nodules and damages the nitrogen foods. We should cut the stems of the plants level with the soil, leaving the roots in the soil. We should then cut the stems and branches into short pieces, and bury them and the leaves in the soil where the roots are.

6. The crop which we want the green manure to feed should be planted soon after the green manure is buried. In the wet season in the Tropics, the soft green parts of the buried plants rot quickly, and the nitrates and other plant foods, which are being made, dissolve in the wet soil. These foods may be washed away by the rain-water if other plants are not ready to use them.

7. We should not try to grow a green manure crop to help the soil and also try to get seeds from it. We must do one or the other, for if we try to do both we shall do neither well.

We can plant the crop and bury part of it as green manure, leaving the other part to grow and produce seeds. Tall legumes like *Crotalaria* and the pigeon pea are suitable for use in this way.

Or we can grow a first crop for seed (and for food, if it is a food crop). Then after harvest we can bury the waste parts and so give some help to the soil. After that we can grow the same crop a second time, burying it when young as green manure. The cow pea is a good crop to use in this way.

8. For green manure crops we should choose legumes (*a*) which grow quickly and grow many green leaves in a short time; (*b*) which can be grown easily from cuttings or quickly from seeds; (*c*) whose stems do not quickly become woody.

9. Tall legumes produce more green manure than climbing or creeping legumes. On an acre of fair soil a crop of *Tephrosia candida* will in the first year produce twenty-seven thousand pounds of stems and green leaves for burying in the soil!

10. Creeping legumes and climbing legumes that are allowed to lie on the soil keep it damp and protect it from the hot sun and the heavy rain. They do this better than the tall legumes.

QUESTIONS

1. Write down the new words in this lesson and learn them.
2. In what kind of soil may we bury the green manure plants deep and while they are still soft and green?
3. Name two kinds of soil in which green manure should not be buried until it has dried for a few days on top of the soil.
4. Why should the roots of green manure plants not be left in the hot sun?
5. What kind of plants make the best green manures?
6. What kind of legumes produce most green manure? What kind of legumes are best for protecting the soil?
7. Why should we plant the crop which we want to feed soon after burying the green manure?

CHAPTER 4

CROP ROTATION AND GREEN MANURES

WISE farmers now know that one of the best ways of helping the soil is to grow green manures as part of their crop rotation. They know that, if green manures are not included in the rotation, the crops they grow keep taking food out of the soil, which soon becomes less fertile.

In Book Four we read that rotation of crops gives better harvests than growing the same crop year after year on the same piece of land. It is also important to grow the crops in the order which best suits the kind of soil. In a rotation we can plant three, four, five, or six different crops, one after the other, before we plant the first one again.

In a good rotation the farmer plants some root crops, like potatoes or yams; some grain crops, like maize or millet; some legumes and green manures. He plants a crop with deep roots after one with shallow roots, because the two crops take food from different layers of the soil. He plants grain crops after root crops, and green manures before the crops that take most food from the soil. If the soil is poor, or if he wants to harvest crops that take much food from the soil, the farmer will grow a green manure crop between each two of the other crops. If he sees that the soil needs it, he will plant two or three green manure crops, one after the other.

These are some crop rotations which help the soil:

I. A short rotation, covering one and a half or two years.

Crop 1. Sweet potatoes. Bury leaves and stems. 3–6 months.
,, 2. *Crotalaria Sesbania* or other tall legume as green manure. 6–9 months.
,, 3. A grain crop like maize or millet. Bury leaves and stems. 3 months.
,, 4. Cow peas for seed and food, then bury. 4 months (The plants may grow up the dead maize stems and the waste of both crops can then be buried.)
,, 5. Cow peas for green manure only.

II. A rotation covering two or three years.

Crop 1. A root crop, sweet potatoes or yams. 4–8 months.
,, 2. Cow peas for food and seed. 4 months.
,, 3. Pigeon pea. Time as needed. 6 months or 1 year.
,, 4. Maize or millet. 3 months.
,, 5. Ground-nuts for food, then bury. 5 months.
,, 6. Cow peas for green manure. 2 months.

This rotation is for a better soil than Rotation 1. The roots and stems of all the crops like potatoes, maize, and pigeon peas should be buried.

III. A long rotation covering about six years.

Crop 1. Yams, cassava, or other slow growing root crop. 9 months to 1 year.
„ 2. *Calopogonium* or other cover crop. 1½ to 2 years.
„ 3. Peanuts for food, then bury leaves and stems. 5 months.
„ 4. Pigeon pea[1] or *Crotalaria* (a tall cover crop). Bury waste. 1½ to 2 years.
„ 5.[2] Pumpkins, water melons, cucumbers, to grow over the woody stems of Crop 4. 5 months.
„ 6. Cow peas for seed and manure. 4 months.
„ 7. Cow peas for green manure. 2 months.

There are many different crop rotations. Different countries and different soils require different rotations; different peoples eat different kinds of food. In some countries the people have to grow much food for their cattle to eat in the cold or the dry seasons. Some soils need more green manures than others. You can get advice about suitable crop rotations from the Agricultural Officer of your district.

QUESTIONS

1. Write down the new words in this lesson and learn them.

2. Name three types (kinds) of crops which we should include in a rotation.

3. Why does a farmer plant a crop with shallow roots after one with deep roots?

---

[1] The pigeon pea is a good two-year cover crop after cassava.

[2] This crop may be left out of the rotation if the farmer does not want to grow it. It does not take much food from the top-soil, and it does not give many leaves to bury as manure.

4. Why is it good to plant a crop with long roots like *Crotalaria* (a tall legume) before maize?
5.Why is it good to plant a shallow root crop like sweet potatoes after cow peas?
6. Find out from your Agricultural Officer or his Assistant short, medium and long rotations suitable for your soil.

CHAPTER 5

GREEN MANURES IN CROP ROTATIONS: HOW THEY HELP THE SOIL

WHEN we bury plants, they rot and put into the soil:

(*a*) plant foods which have been made by the plants from the air and from the soil;
(*b*) humus;
(*c*) nitrogen foods made by microbes in root nodules.

Different crops planted in a rotation use different foods from different layers of soil, so that too much food of the same kind is not taken from any one layer.

By using a rotation the soil can be kept covered most of the time, so that the hot sun and heavy rain do not damage it.

Green manures, weeds, grass, and plant waste buried in the soil improve its texture. (See Book Four, Ch. 11.) Burying these things tills the soil at the same time. This lets air and water into the soil. The dead plants are changed into humus and the microbes increase and multiply. The good soil gets deeper and the amount of plant food increases also.

Legumes have long tap roots, which may grow as far as ten feet down into the soil. These roots slowly change the sub-soil, making it better and more like the top-soil. The side roots spread wide on either side of the tap root, opening up clay soils and holding sandy soil together.

The number of weeds gets less because those that grow are buried before they seed. Seeds which are brought to the garden by the wind are also buried. When seeds are buried deep in the soil they cannot grow.

An insect or disease does not usually attack more than one kind of crop. If we plant the same crop often in the same garden, the bad insects increase and the disease spreads from plant to plant. If we change the crops grown in the garden, the insects and diseases do little damage to any of them. Some insects and diseases can live only on one kind of crop and they die out altogether through lack of food if this crop is not planted too often.

When green manures are grown in the crop rotation, the crops sometimes become better quickly. Sometimes we must wait several seasons or several years before we see any improvement. Soils which need only more plant foods become better more quickly than soils which have not enough humus microbes in them, and are unfertile.

In the Tropics it takes a long time to build up soil fertility again after it has been lost. The soft parts of dead plants rot very quickly in the heat, and even the hardest parts do not last long. In cold countries both soft and hard parts rot more slowly, so a store of plant food is built up and remains longer in the soil.

If our tropical soil needs humus, we must bury much green manure very often. We may have to grow many crops of green manure over several years before we see much improvement in the soil. Most tropical soils which are not producing good crops need humus more than anything else.

QUESTIONS

1. Write down the new words in this lesson and learn them.
2. Name three things which buried plants, including legumes, put into the soil.
3. Name two other ways in which green manures help the soil.
4. What do most tropical soils need more than anything else? Why?
5. How do the roots of legumes help the soil?

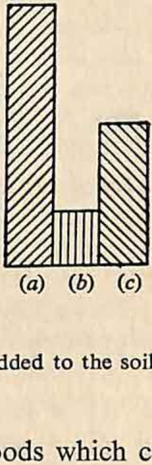
CHAPTER 6

SOME EXPERIMENTS WITH GREEN MANURES AND FOOD CROPS

Experiment 1.

Some men who were studying plants and soils grew cow peas on a number of different gardens. They found that, when the plants had been buried and had rotted, these amounts of plant food had been added to each acre of soil:

106 pounds of nitrogen foods (a).
22 pounds of phosphorus foods (b).
77 pounds of potash foods (c).

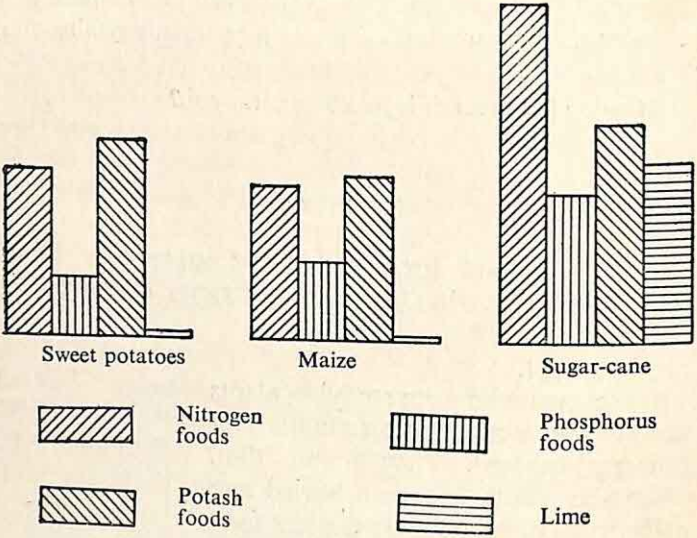


Experiment 1. Amounts of plant food per acre added to the soil by cow peas used as a green manure.

This experiment showed that, of the foods which cow peas put in the ground, the greatest amount was nitrogen foods.

Experiment 2.

Other men grew different crops in a number of different gardens, and worked out how much of the different plant foods each acre of the crops had used. They got these results:



Experiment 2. Amounts of plant foods used per acre of crop.

	Nitrogen foods	Phosphorus foods	Potash foods	Lime
1. Sweet potatoes ...	67 lb.	24 lb.	79 lb.	2 lb.
2. Maize ...	61 lb.	31 lb.	66 lb.	14 lb.
3. Sugar-cane ...	136 lb.	59 lb.	87 lb.	71 lb.

The results show us that sweet potatoes need very little lime and much potash. They also show that sugar-cane takes much of all the plant foods from the soil, which quickly becomes hungry.

Experiments like these help to show farmers what foods to put in the soil for different crops.

Experiment 3.

If you carry out this experiment, you will be able to see how a green manure crop, like cow peas, helps the soil.

Plant cow peas in lines about two feet apart. When the first fruits to form are about one inch long, cut down and bury the plants in the lines where they have grown.

Then plant *Sesbania* or *Crotalaria* seeds close together in lines crossing at right angles the lines of cow peas. When the second crop begins to grow, you will see that, at the places where the lines cross, the plants are growing better and more quickly, and that, the farther they are from the lines of buried cow peas, the shorter the new plants will be. Each line of plants will rise and fall like waves on the sea.

This experiment shows that cow peas improve the soil quickly when they are used as a green manure. It also shows that if we want to improve the soil everywhere in the garden we must grow the green manure plants close together. They help the soil only in the places where they grew and were buried.

QUESTIONS

1. Write down the new words in this lesson and learn them.
2. Of what food do cow peas put the greatest amount into the soil?
3. Should you put much lime on a sweet potato garden?
4. Should you put ash on a sweet potato garden?
5. Would you plant a root crop after a crop of sugar-cane? Explain why.

CHAPTER 7

ANNUALS, BIENNIALS, AND PERENNIALS

SOME plants grow quickly, produce flowers, fruit, and seeds, and then die—all in one year. These are called annuals, a word which comes from the Latin word *annus*, meaning a year. The next year's plants grow from the seeds produced by the plants of the year or season before. Cow peas, maize, pumpkins, *Sesbania*, and many other plants are annuals.

There are other plants which do not die in the first year and whose stems become hard and woody. Some of these plants live for only two years, and are called bi-ennials. *Bi* means two. Some biennials (certain kinds of beans, etc.) flower in both the first and second years. Others, like the carrot, store food in their roots in the first year, and flower in the second year. In the first year, the leaves of the carrot grow close together at the top of the plant; it is at this stage that carrots are usually dug up and used as food. If they are allowed to stay in the soil for a second year, each carrot grows a long stem bearing leaves and flowers and, later, seeds.

Other plants live for several or for many years, and are called perennials. Some like the pawpaw and pigeon pea begin to flower in the first year, and go on flowering until they die after several years.

Other perennials, like coconut, orange, and mango trees, grow for five or more years before they begin to flower. The stems become thick and the soft green skin changes to hard, dark brown bark. Some trees live for hundreds of years, their stems, or trunks, becoming thicker each year. The trunks of some old trees measure many feet round.

QUESTIONS

1. Write down the new words in this lesson and learn them.
2. What is an annual plant? Name three.
3. What is a biennial plant? Name two.
4. What is a perennial plant? Name three.
5. Which of these three kinds of plants would you grow as a green manure?

CHAPTER 8

COVER CROPS

YOU know that green manures are plants, often legumes, which we grow and bury in the soil when they are still young and green. When legumes are also grown as cover crops, they are not buried when young and green. They are allowed to grow and cover the soil from one season, or one year, to another. They may be allowed to remain for several years, keeping the soil clear of weeds and protecting it from the sun and heavy rain. Their leaves add much humus to the soil, while their roots hold it together and increase the nitrogen foods in it.

Creeping cover crops, like *Calopogonium* and *Centrosema*, help the soil very much in all these ways. Then, if the stems have not become too woody, the plants can be buried when the garden is wanted for a new crop. If a creeping cover crop is grown in a garden for several years, the tops of the plants can be cut twice a year and the leaves and young stems left to rot on the soil. This adds to the humus in the soil and the plants soon grow new branches and leaves. Cover crops may be planted as part of a rotation and left to grow for one or more years, or they may be grown between the rows of another crop. (See Ch. 11.)

Tall cover crops also give much green manure to the soil if their tops are sometimes cut. This is done when the plants are about two and a half feet high, and they are cut down to about one and a half feet above the ground. If they are cut when too young, or if they are cut down too short, they may die.

It is best to hoe up any weeds first and put them between the lines of plants. Then, when the tops of the plants are cut, they also fall between the lines, and soil can be put over both to help them to rot more quickly without loss of plant food. (This, of course, cannot be done with a creeping cover crop.)

Many new branches soon grow, and this time we allow the plants to grow taller than two and a half feet before we cut them again. At this second cutting, the plants should not be made shorter than two feet above the ground. The weeds and the tops are again buried together between the rows of plants.

We can go on cutting the tall legumes like this, but at each cutting the plants must be left six inches higher than at the cutting before. This makes sure that we leave many buds from which new branches can grow. If the plants are cut down each time to the same height from the ground, they may die.

If we want to clear away the tall legumes to make room for another crop, we first cut away all the green branches and the leaves. These we bury between the lines of plants Then we cut the stems level with the top of the soil, and, if the plants are old and the stems have become woody, we cut them up into short pieces. If we bury these pieces deeply enough where the plants were growing, they will probably have rotted before we dig that piece of ground again. Another thing we can do with the pieces of woody stem is to take them to a different part of the garden and leave them to rot on the top of the soil, growing a crop of cow peas or pumpkins over them. Later, the partly rotted stems and the remains of the crop that has been growing over them can be buried together. A third thing we can do with the stems, though it is not so good as the other two, is to burn them at the side of the garden and scatter the ashes on the soil.

QUESTIONS

1. Write down the new words in this lesson and learn them.
2. What is a cover crop?.
3. What kind of plant would you use as a cover crop—an annual, a biennial or a perennial?
4. In what ways does a cover crop help the soil?
5. How can we make a cover crop give the greatest amount of help to the soil?
6. To what height above the ground would you cut down a tall cover crop the first time, and afterwards?
7. What would you do with the plants of a cover crop if you wanted to plant another crop on the same piece of ground?

CHAPTER 9

PLANTING COVER CROPS

THERE are several ways of planting creeping cover crops. On gardens, where the land has been cleared, the seeds can be scattered. If the seeds are very small, they can be mixed with a little dry soil, and the seeds and soil scattered together. This is a useful way of planting if there are not many seeds or if we do not want them to fall too close together.

If we have plenty of fruits with seeds in them, or if we want the plants to grow close together, we can plant the fruits as they are.

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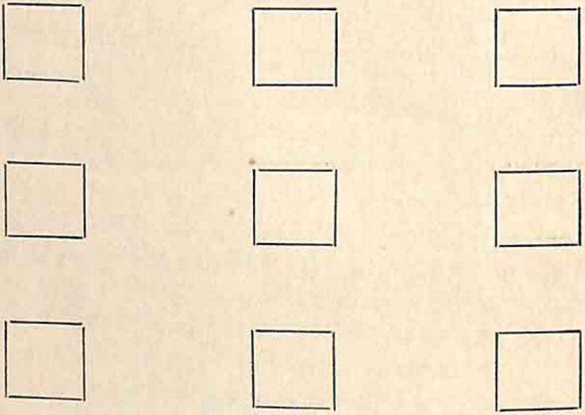
If we want a cover crop to take the place of weeds or grass, perhaps in a plantation[1] of coconuts, bananas, or other trees, we can first clear little squares of soil, each square with sides two or three feet long and from four to six feet from the squares next to it. The cover crop seeds are planted close together on the cleared squares, which are then kept clear of weeds. When the cover crop is growing well on the squares, the spaces between them are cleared, and the cover crop spreads from square to square over the whole plantation.



SQUARES CLEARED FOR A COVER CROP

Some creeping cover crops grow well from cuttings. From a plant like *Calopogonium* the cuttings should be taken with little roots growing from the nodes.[2] They should only be taken when there has been enough rain to make the soil very damp. They will die if cut and planted when the soil is dry.

There are also several ways of planting tall cover crops.

---

[1] Plantation: A large amount of land on which tea, coconuts, etc., are grown.

[2] Node: The place on the stem of a plant where the leaf grows.

For a short time cover crop we can plant the seeds close together in lines that are near each other. If this is done the crop grows in "belts". (See Ch. 2.) This is the best way of planting a short-lived crop like *Sesbania*, which will be on the soil for about six months and will be cut often. There should be one or two feet between the belts, and in this space the cut tops of the plants should be buried.

The seeds of a cover crop, which will grow for a longer time and will be cut often, may be planted two feet apart in rows also two feet apart. When planted like this and properly "topped", the plants will give much green manure to the soil for about a year. There will often be shade between the rows, so that not many weeds will grow.

If a crop is to cover the soil for two or three years, the seeds must be planted so that the plants, which will grow tall, have plenty of space to grow. When they are big they will need from three to five feet between the rows, and between the plants. The seeds can be planted with this spacing, but, before the plants have time to grow, weeds will spring up between them.

A good way to avoid this is to plant the seeds one to two feet apart in rows three feet apart. When the plants are small they will grow well, and, though cut often, they will be near enough to each other to give some shade to the soil. When they are taller, some can be cut down level with the top of the soil, giving space for those left to spread their branches wider.

If the cover crop is to be grown for seed, or for food and seed as is sometimes done with the pigeon pea, there will have to be four or five feet between the plants and between the rows. They will not be "topped" often for green manure; they will spread wide and will grow to six or eight feet in height. When the seeds have been collected at the end of the season, the plants can be cut down to about one or one and a half feet high. In the following year they will grow tall again.

QUESTIONS

1. Write down the new words in this lesson and learn them.
2. For what reasons would you mix dry soil with Calopogonium seeds before scattering them in the garden?
3. How would you grow a creeping cover crop in a plantation?
4. How would you plant a tall cover crop, which is to grow for a short time and to be cut often?
5. What is the best way to plant a tall cover crop, which is to grow for several years?

CHAPTER 10

HOW A GOOD PASTOR HELPED FARMERS

IN a district in the State of Tennessee, one of the United States of America, there were no trees and the soil was very poor. The top-soil had been washed away, and when it rained the few roads were deep in mud. The people could not grow enough food for themselves and they were very poor. Their houses were bad, and their clothes were torn and in rags. Often they could not get money to buy the things they needed, and they were both sick and sad.

In the whole of this big district there were only four churches, and only eighty-nine people ever went to Church. No pastor or priest who was sent there stayed for long, because they did not know how to help their people. In twenty-five years twenty-eight different pastors went there —and went away again. Yet pastors are the shepherds of their flocks, and are sent to help them to live better lives.

Then, in 1915, Paul Doran, a different kind of pastor, went there. By 1942 he had changed the whole district. He had then eleven churches with twelve hundred people attending them. A hundred and twelve miles of good roads had been made. The farms were producing good harvests and the farmers were happy. They had good houses and were able to give their families good food and clothes. From being sick and sad the people had become healthy and happy.

This is what happened. When Paul Doran arrived in his poor district, he did not follow the pastors before him in thinking, "This is a difficult place, and I do not like it. I do not see how I can help these people, so I shall go away again." He tried to find out why the people were so poor and sad, and he soon saw that it was because the soil was not fertile. He decided that he must show them how to improve their land.

He dug up a poor piece of land behind his church to make a garden. The first year he got only two bags of corn from his garden. The next year he divided the garden into two strips, in one of which he again planted corn in the old way known to all the farmers. In the second strip he first planted beans, clover, and alfalfa,[1] which he buried. He then put lime on the soil, and later planted his crop. That year he got a better harvest from the second strip than from the first one. From that time he planted green manures between the rows of his food crops, and every year the harvests got better.

Paul Doran spent part of his time working in his garden and part visiting his people. When the farmers saw that he was getting better harvests than they were, they wanted to know the reason. In order to teach them he opened an evening school. So the farmers, after working hard all day

[1] Alfalfa: A plant with leaves like clover much used for feeding horses and cattle.

in their gardens, came to school for two hours every evening! They learnt about the soil and about ways of helping it by the rotation of crops, the use of green manures, and so on.

With the help of the farmers Paul Doran made a small room in his house into a school room. Here the farmers brought little tins of soil from their farms, so that they could study the different kinds and learn about them. Paul Doran helped them to find out what were the best green manures and food crops to grow on these soils, and helped them to plan their rotations.

The next year Paul Doran began different lessons in the evening school. The farmers brought their wives and they learnt about gardens, houses, cattle, pigs, nursing and First Aid. They talked about their own district and country, and about other countries. He read books to them and lent them books to take home to read. The people had many new things to think and talk about, and had a new interest in their homes and farms and country. With better farms and better food, with happy minds, worshipping God and helping each other, the people became better in body, mind, and soul.

Then Paul Doran bought good cattle, pigs, and hens. He showed the farmers the value of good stock and taught them how to use animal manure. (See Book Six, *More Food for the Soil.*) He held shows each year and gave prizes for the best gardens, the best houses, the best animals and the best babies! In 1942, after twenty-seven years' work among his people, Paul Doran got 73 bags of corn from an acre of his land. In 1915 he had got only 2 bags. On seventy-nine farms in the district green manure was being grown, and half the farms in the district had been limed.

When the people saw that Paul Doran was a true friend and helper in their daily lives, they wanted to listen to all his teaching. He was a true shepherd of his flock, and soon so many people came to Church that the four churches were not enough. So the people worked in their free time, without wages, to build more churches. Some of them worked for four hundred and seventy-one days breaking and preparing the stone for a single church. At last there were enough churches for all the people to go there and worship God, and Paul Doran and his people were really happy. God has blessed their work, and they all praise Him for His goodness.

QUESTIONS

1. Write down the new words in this lesson and learn them.
2. Where is the State of Tennessee?
3. Why were the people so poor when Paul Doran first went there?
4. How did Paul Doran improve the soil of his garden?
5. Name some of the things the farmers learnt in evening school.
6. How did Paul Doran help the people to become interested in new things?
7. What do you think was Paul Doran's reason for holding shows and giving prizes?

CHAPTER 11

MORE ABOUT MIXED CROPS

IN Book Four, *Better Ways of Farming*, we read that, many years ago, farmers sometimes planted mixed crops in a garden. To-day some farmers are again planting mixed crops, but now they do it in a different way. They do not mix beans and corn and potatoes together; they grow a cover crop between rows in young plantations of coconuts, oranges, rubber, cocoa, bananas, tea, and so on.

When these plants are big there must be plenty of space between them to allow them to grow well. So when they are young the soil has to be protected from the sun and the heavy rain, while the young plants themselves need shade. Some of them grow slowly, and they will grow even more slowly without shade and good soil. A cover crop planted between the rows of young seedlings will shade them, keep down the weeds and help the soil. Young cocoa plants die if they are not given shade, and other plants are greatly helped by it.

When the plants have become big, there may still be a cover crop on the soil. If it is a creeping cover crop, it must not be allowed to grow too near the plants of the chief crop. There must be a clear space of from four to six feet round each tree or each group of banana plants. The soil in the clear spaces can then be tilled and manured, and air and rain let into the soil to help the plants to grow.

QUESTIONS

1. Write down the new words in this lesson and learn them.
2. Would you plant a creeping or a tall cover crop between the rows of young cocoa plants?
3. If you have a creeping cover crop in a cocoanut plantation, what size of clear space would you leave round each tree?
4. Why is it necessary to have this clear space?

CHAPTER 12

COW PEAS: A GOOD GREEN MANURE

Cow peas are a very good green manure crop because they grow very quickly, and on any kind of soil—clay, sand, or loam—if the rain water can run away easily.

They like good soil, but they will grow better on poor soils than many other crops. The plants also rot very quickly when buried. In the wet season in the Tropics, they rot so quickly that the foods they put into the soil may be used by the next crop in a few weeks or may be washed away by the rain.

Cow peas grow well in the same kind of soil as maize. Because of this it is useful to plant them under maize when the maize begins to form its tasseled flowers. The cow peas climb up the maize stems, and, when the maize has been harvested, the two crops can be buried together.

There are several kinds of cow peas; some are short plants and some are tall climbers. The best for green manure are those which have many leaves. Cow peas begin to flower six weeks after the seeds have been planted, and they are ready for burying in seven or eight weeks. If there is any rain, they have all rotted in the soil after another month. Some kinds of cow peas have red seeds, some have black seeds, some have brown seeds, and some have seeds of mixed colours. The cow pea with black seeds is the oldest kind we know, and was first grown in India and China. The kind with brown seeds have pods nine inches long and often make the best green manure crop.

When cow peas are used as a green manure crop the seeds are planted in rows one, two, or three feet apart, with six to nine inches between the seeds. On an acre of land (an acre is a square with sides about seventy yards long) a farmer needs about thirty-five pounds of seed if the rows are one foot apart. If the rows are five feet from each other, he will need about 12 pounds of seed.

Cow peas are good food, either fresh or dried. In parts of Africa the people grind the dry peas to make pea flour. The flour is mixed with water to make porridge, or is made into balls, which are fried or eaten with soup. The young cow pea shoots can be boiled as a vegetable, and are like cabbage when cooked.

Cattle and pigs like the leaves, shoots, and fruit. In some countries the pigs are tied to trees or posts in the cow pea gardens. There they become fat and help the soil with the animal waste they leave. In America many farmers grow cow peas as green manure and as food for themselves and their animals.

QUESTIONS

1. Write down the new words in this lesson and learn them.
2. Why are cow peas a very good green manure?
3. What parts of the plant are good food for men?
4. How can we prepare cow peas as food for ourselves?
5. What animals eat cow peas?
6. In what countries were cow peas first grown?
7. How do American farmers use cow peas?

CHAPTER 13

MORE GREEN MANURES AND COVER CROPS

PEOPLE in South America and Africa grow velvet[1] beans for use as green manures. The pods of the velvet bean are shorter and wider than the pods of the cow pea, and they have many dark brown hairs on them. The seeds are brown and white in colour.

The plants like plenty of rain, and have many leaves of which cattle are fond. In America and Africa they are planted under maize like the cow pea, and they are being used in this way in other parts of the world as well.

Pigs like the dry pods and seeds; cattle and hens eat the seeds, but they must be taken out of the pods for them. People can also eat the seeds, which must be boiled in water and this water thrown away. Fresh water should then be used and the beans cooked in it.

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[1] Velvet: Cloth with short threads standing upright giving it a soft, thick surface.

Another useful plant is the sword bean, some kinds of which are short, like little bushes, while others climb. Their pods are flat, sword-shaped, and about a foot long when ripe. The seeds are big and have tough skins. When young they are green and when ripe they are red, white, or yellow.

If the seeds are well-cooked they make good food. They should first be soaked in water for two hours and then boiled. After they have been boiled for a little, the tough skins burst and can be taken off the beans. The beans must then be cooked for a long time, and afterwards they can be made into good soup or into bean flour. The very young green pods can be cut into thin slices and cooked as a green vegetable.

Sword beans grow well on loam soil, and do not need much rain. The bush kind can be planted close together as a quick green manure crop, but the plants must not be allowed to grow for more than a few weeks, as the stems become woody when still small.

There are many other beans, such as the Lima, Soya, Wing, Epicure, and Scarlet Runner bean. Many of them are good food for men or animals, or for both. They all belong to the legume family, and will help the soil even if the plants are only buried after the beans have been harvested for food or for seed.

Calopogonium is a creeping plant with hairs on the stem, leaves, and pod. It likes a deep top-soil with some humus in it, and it does not like coral soil or shade. The plants spread slowly at first, but in five months they make a thick cover on the soil, killing other plants and weeds and dropping many soft, dead leaves to rot on the ground.

Roots grow at the nodes on the stems, and cuttings taken with these roots grow well if planted in wet weather.

Calopogonium flowers best in the dry season, and may go on flowering for several months. The pods, which are dark brown, hairy, and an inch to an inch and a half long, ripen in about three months, and contain small, yellow seeds.

The plants have many short roots, which do not go deep into the soil. Because of this the root nodules help only the top layers of soil, and the plants sometimes die in the dry season. When it rains the seeds that have fallen from the crop before begin to grow, and the soil is soon covered again. So the plant will grow year after year as a cover on the same piece of ground. *Calopogonium* is therefore a very good cover crop and green manure. It protects the soil, and puts much humus and nitrogen foods into it.

When *Calopogonium* is planted on a garden, the seeds should be scattered close to one another. If land under coconuts, rubber, bananas, etc., is to be covered with *Calopogonium*, it should be planted as described in Ch. 9 of this book. Some farmers plant the ripe, unopened pods, because this keeps the seeds from being blown away by the wind.

There are other legumes which make good creeping cover crops. *Centrosema* at first grows more quickly than *Calopogonium*. It does not like poor soil, has deeper roots and does not die in the dry season.

Dolichos hosei will grow in shade from either seed or cuttings. It grows quickly, but does not give such a thick cover as the the other two.

Desmodium covers the soil quickly and will grow in deep shade. *Indigofera* makes a very thick cover, but does not like shade. *Mimosa invisa* quickly gives a thick cover and is very good for the soil. It has thorns and should not be used on land under cocoa.

QUESTIONS

1. Write down the new words in this lesson and learn them.
2. Describe the pods and seeds of the velvet bean. Why do you think this name was given to it?
3. How should sword beans be cooked?
4. Why are beans so useful as a green manure crop?
5. Why do *Calopogonium* plants sometimes die in the dry season?
6. How would you plant *Calopogonium* in a plantation?
7. In what ways is *Centrosema* different from *Calopogonium*?

CHAPTER 14

TALL COVER CROPS AND GREEN MANURES: *CROTALARIA* AND *SESBANIA AEGYPTIACA*

Crotalaria came to us from Asia. Though there are several different kinds of *Crotalaria*, they are all plants that grow to about seven feet high. They are biennials or perennials, and have long tap roots which help them to live through the dry seasons. The flowers are yellow and begin to appear two or three months after planting. The pods are rounded, not flat like those of the bean. The seeds are flat, yellow, brown, or grey in colour, and rattle together when the ripe pods are shaken.

Ways of planting the seeds for a green manure or a cover crop are described in Ch. 9.

Sunn Hemp (*Crotalaria juncea*) is different from the other crotalaria plants. The leaves are simple and there are hairs on the stem. The plants grow to about eight feet high, and do well in poor soil even where it is dry. They make a very good green manure or cover crop.

When planting, the seed should be sown three or four inches apart.

Sunn Hemp grows well in India. There the people feed their cattle with the leaves and seeds, and make good string from the stems. When they are in flower, the plants are cut down level with the ground, and the stems are tied in bundles of a hundred. These are dried in the sun for two or three weeks, and are then put in still, shallow water for six to eight days. Then they are retted, and from the fibre[1] the people make string, rope, and fishing nets. The string is as strong as that made from true hemp, which explains why the name Sunn Hemp is given to the plant.

Sesbania aegyptiaca grows very well in India as a tall green manure or a quick cover crop. It is an annual and flowers soon after planting, sometimes when only a foot high. If there is enough rain it may grow as tall as fifteen feet in some seasons. The flowers are small and yellow, while the fruits are long, very narrow, and dark brown in colour. The seeds are brown and are longer than they are wide.

Sesbania improves soils which have too much salt in them, and makes very good humus. When the crop is planted as a green manure the seeds should be sown close together, and the plants should be buried when two and a half to three feet high. When the crop is grown for seed, the plants should be three to five feet apart.

The pigeon pea is a good cover crop for about two years, but it does not grow well in the third year. It is a good crop to grow on soil where cassava (manioc) has been growing. The bushes, which are about six feet high, give good shade if they are planted in rows three feet apart. This spacing keeps weeds from growing between the plants.

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[1] Fibre: A thread-like part of anything.

The pigeon pea, which comes from India, likes deep loam and not much rain. Where there is too much rain the fruits and seeds are likely to be damaged by disease. The young fruits appear in four to six months after planting, and the young seeds in them are good for eating when cooked like "green" peas. If the crop is grown for food and seed, the plants are often spaced out to five or six feet apart. After the first year's harvest, the stems are cut at the height of one foot above the ground; the next year they will grow many new branches and give another harvest. In India the dried pigeon peas are called *dhal* and are much used in soups and curry. If they have been dried, the peas should be soaked in water for a few hours before being cooked.

Goats, cattle, sheep, and fowls all like the pods and seeds. Hens also like the peas dried and broken.

Tephrosia are tall cover crop plants like the *Crotalaria* and the pigeon pea. They like good loam soils from which the water flows away easily, but will also grow well on a poor soil. Weeds will not grow in the shade of the plants, which have deep roots and will live through the dry season. The crop will grow well for three years, and the plants can be cut down as described in Ch. 9. A farmer, who had planted *Tephrosia* on an acre of land, cut it down four times, and so put fifty-eight tons of green manure on the soil. When the crop gets older it may be damaged by disease and caterpillars.[1]

Leucaena glauca is a tall cover plant which is also very good for the soil, and which is grown in many places in Java to shade the cocoa plants. It can be "topped" often, and disease and insects do not damage it much. It grows easily from seed or from cuttings in the wet season. It does not grow so tall as *Crotalaria* or the pigeon pea, and gives a light shade. The leaves and young cuttings are eaten by cattle, which also eat the cooked and broken seeds. The woody stems can be used as firewood.

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[1] Caterpillar: A worm-like creature which later changes into a flying insect.

QUESTIONS

1. Write down the new words in this chapter and learn them.
2. From what cover crop plant can good string be made?
3. What is a good cover crop to plant on soil where cassava has been grown?
4. Which green manure crop helps salty soils?
5. What kind of soil does *Tephrosia* like?

These are some of the new words in this book:

1. annuals; biennials; perennials; plantation; scatter; thicker.
2. shepherd; seasons; fibres; nodes; stock; creeping.

Complete these sentences by using words from line 1.

(*a*) A large area of land on which tea is planted is called a ....

(*b*) .... grow up and die in their first year.

(*c*) If we want plants to grow close together, we may.................... the seed on the soil.

(*d*) .... live for several or for many years.

(*e*) The trunk of a tree is .... than its branches.

(*f*) .... live for two years.

Complete these sentences by using words from line 2.

1. Cover crops may remain on a garden for several ....
2. The .... stems of *Calopogonium* have little roots at the ....
3. A pastor is the .... of his people.
4. Good string can be made from the .... of Sunn Hemp.
5. A farmer's cattle and other animals are called his ....

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